COST AND PERFORMANCE REPORT FOR THE TRANSPORTABLE HOT-GAS DECONTAMINATION SYSTEM USED TO SUPPORT THE DECONTAMINATION OF EXPLOSIVES-CONTAMINATED PIPING AND DEBRIS

Contract No. DACA 31-91-D-0079
Task Order 12

Prepared for

U.S. ARMY ENVIRONMENTAL CENTER (USAEC)
SFIM-AEC-ETD
Edgewood Area
Aberdeen Proving Ground, MD 21010-5401

September 1996

Prepared by

ROY F. WESTON, INC.
1 Weston Way
West Chester, Pennsylvania 19380-1499

TABLE OF CONTENTS

LIST OF FIGURES

Title **Page**

LIST OF TABLES

1. INTRODUCTION

1.1 BACKGROUND

For many years, the United States Army has engaged in a wide variety of operations involving the handling and disposal of explosives materials at various military installations. Past operations at these installations have included the manufacture, storage, testing, and disposal of explosives that have resulted in the contamination of process-related equipment, sewers, piping, and structures. As a result of these activities, the Army currently owns a large inventory of materials that are contaminated with explosives.

Demilitarization of explosives-contaminated process equipment and structures has proven to be difficult and expensive for the Army. Currently acceptable methods for decontamination of explosives-contaminated materials include 3X treatment methods such as steam cleaning and power washing, and 5X treatment methods that involve heating contaminated materials to a minimum temperature of 1,000 °F for 15 minutes. Although steam cleaning effectively decontaminates the surfaces of contaminated materials to a 3X condition, contaminants may still be present in the surface voids or equipment internals. At present, there is no analytical method available that accurately determines the contaminant concentration remaining in the pores of treated materials. In order for the materials to be released from government control (i.e., landfilled, scrapped, or reused), the materials must meet 5X treatment criteria.

In some instances, the 5X treatment process is controlled by flashing contaminated materials within an enclosed oven, but more commonly the process is uncontrolled and accomplished by open air burning and/or open detonation (OB/OD). Because environmental regulations are becoming more rigorous every year, it is likely that the practice of OB/OD for decontamination of explosives-contaminated materials will be severely limited or disallowed because OB/OD results in nonregulated air emissions. Although flash ovens allow for control of process off-gases, the process is essentially an incineration process that currently carries negative perceptions by both the public community and regulatory agencies. Materials decontaminated using either OB/OD or flashing methods are usually not suitable for reuse and must be scrapped or landfilled.

In summary, these currently accepted decontamination methods have proven a need for a technology that is easy to use, capable of destroying undesirable emissions, and does not result in complete destruction and loss of equipment and/or structures. The HGD technology discussed in this report meets these requirements. Subsection 1.2 presents the history of the HGD technology and subsequent sections present the transportable HGD system equipment listed at the Alabama Army Ammunition Plant (ALAAP). Specific details regarding site layout, utilities, operating costs, and system performance will be provided.

1.2 HISTORY

The U.S. Army Environmental Center (USAEC, formerly United States Army Toxic and Materials Agency or USATHAMA) began conducting laboratory investigations and pilot-scale studies in 1978 to evaluate the effectiveness of the HGD technology on explosives- and agent-contaminated materials and structures.

Based on promising laboratory work with chemical warfare agents, a pilot-scale study using agent-spiked samples was conducted at Dugway Proving Ground, Utah[1] from February 1986 to October 1987. This controlled pilot-scale study successfully demonstrated the ability of the hot-gas process to decontaminate agent from a concrete and steel structure.

To further evaluate the HGD process on agent, USAEC selected a mustard thaw pit at the Rocky Mountain Arsenal in 1994 for a field demonstration of the HGD process.[2] Three tanks (two 2,600-gallon tanks and one 250-gallon tank) were also left in the mustard pit during the field demonstration to test the effectiveness of the hot-gas process in decontaminating process equipment. This field demonstration once again proved the effectiveness of the HGD process. Mustard agent was successfully decontaminated from the concrete pit, contaminated steel tanks, and process off-gases.

Based on the successful pilot-study results at Dugway (February 1986 to October 1987), USAEC determined to investigate the effectiveness of the HGD process on explosives-contaminated materials. Pilot-scale tests using the HGD process to treat explosives contamination were conducted at the Cornhusker Army Ammunition Plant.[3] Results from the Cornhusker tests indicated that the HGD process seemed to be effective at treating explosives-contaminated materials. To verify this finding, USAEC contracted for additional hot-gas studies to be conducted at the Hawthorne Army Ammunition Plant [4,5] using an existing flash

[1] Pilot Plant Testing of Hot-Gas Building Decontamination Process; Task Order 1. Report No. AMXTH-TE-CR-87130. Prepared by Battelle Columbus Division. 30 October 1987.

[2] Final Technical Report, Field Demonstration of the Hot-Gas Decontamination System. Report No. SFIM-AEC-ET-CR-95011. Prepared by Battelle Pacific Northwest Laboratories, Parsons Engineering Science, Inc., and Battelle Columbus Operations. February 1995.

[3] Pilot Plant Testing of Caustic Spray Hot-Gas Building Decontamination Process; Task Order 5. Report No. AMXTH-TE-CR-87112. Prepared by Arthur D. Little, Inc. August 1987.

[4] Task Order 2; Pilot Test of Hot Gas Decontamination of Explosives-Contaminated Equipment at Hawthorne Army Ammunition Plant (HWAAP) Hawthorne, Nevada. Report No. CETHA-TE-CR-90036. Prepared by Roy F. Weston, Inc. July 1990.

[5] Demonstration Results of Hot Gas Decontamination for Explosives at Hawthorne Army Depot. Report No. SFIM-AEC-ET-CR-95031. Prepared by The Tennessee Valley Authority Environmental Research Center. September 1995.

chamber modified for the hot-gas process. Explosives-contaminated machinery and piping and metal debris, such as shell casings, were treated in one study in 1989 by WESTON. Explosives contained within munitions, such as ship mines, depth bombs, and 106-mm 5-inch projectiles, were treated in a second series of tests in 1994 by the Tennessee Valley Authority Environmental Research Center (TVA). The results from these studies verified the effectiveness of the HGD process in treating explosives-contaminated materials, but indicated that equipment enhancements would be required to optimize the process.

Based on engineering data gathered during the Hawthorne pilot studies, WESTON, under contract to USAEC, was requested to design and supply an HGD system that would be transportable and easily procured through commercial sources. This equipment was delivered to ALAAP located near Childersburg, Alabama, to conduct demonstration tests using clean, noncontaminated debris, and validation testing using explosives-contaminated piping and debris.

Demonstration and validation tests conducted between December 1995 and March 1996 by WESTON at ALAAP optimized treatment conditions for explosives-contaminated materials and debris, and modified the transportable HGD system equipment to enhance heat distribution in the furnace and general system operability.

The transportable HGD system equipment that was demonstrated and validated at ALAAP is the subject of this Cost and Performance Report. This Cost and Performance Report will provide an equipment and system description, installation and utility requirements, operating cost, and system performance for various treatment waste quantities and feed rates.

2.
PROCESS EQUIPMENT DESCRIPTION

The Hot-Gas Decontamination system consists of the following major components:

- HGD furnace.
- Interconnection Duct.
- Induced Draft (I.D.) Fan.
- Thermal Oxidizer.
- 24-Foot Stack with an 8-Foot Extension.
- Data Logging and Monitoring System.
- Remote Control System.
- Continuous Emissions Monitoring (CEM) System.

This equipment, whose general arrangement and process flow are depicted in Figure 2-1 and Figure 2-2, respectively, was used to conduct successful equipment demonstration and validation testing at ALAAP between December 1995 and March 1996. System modifications performed during this period are incorporated in the equipment descriptions provided in this section.

2.1 HGD FURNACE

The HGD furnace was supplied and manufactured by L&L Special Furnace Co., Inc., of Aston, Pennsylvania. The furnace is a natural gas or propane gas-fired, box-type furnace with integrated ceramic-fiber lining. The HGD furnace system includes:

- Furnace Chamber.
- Burner and Gas Train.
- Burner Control System.
- Burner Combustion Air Blower.
- Local Control Panel.
- Remote Control Panel.

All of the furnace components, except for the remote control panel, are skid-mounted for easy transportability. The furnace skid is approximately 16 feet long by 8 feet wide. The remote control panel is shipped separately and requires mounting in a remote control area.

The furnace is heated by a 1 million British thermal units (Btu) per hour, high-velocity nozzle-mix Eclipse Burner equipped with an ultraviolet (UV) sensor and an Industrial Risk Insurers (IRI) class gas safety system. The pilot and burner flames are monitored by a pilot and flame scanner system. Once all system interlocks are confirmed and the pilot flame is established, the main

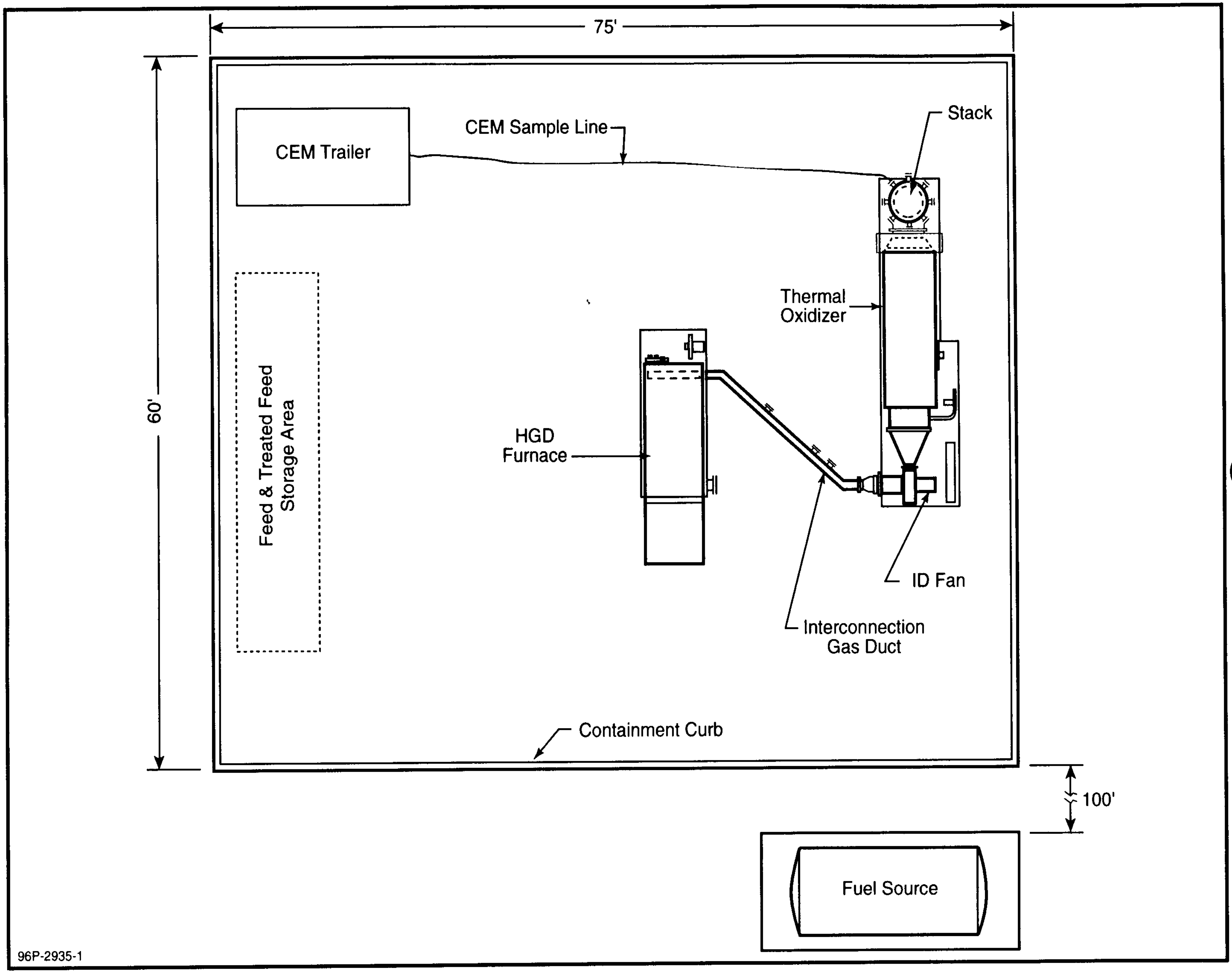


FIGURE 2-1 HGD SYSTEM GENERAL ARRANGEMENT

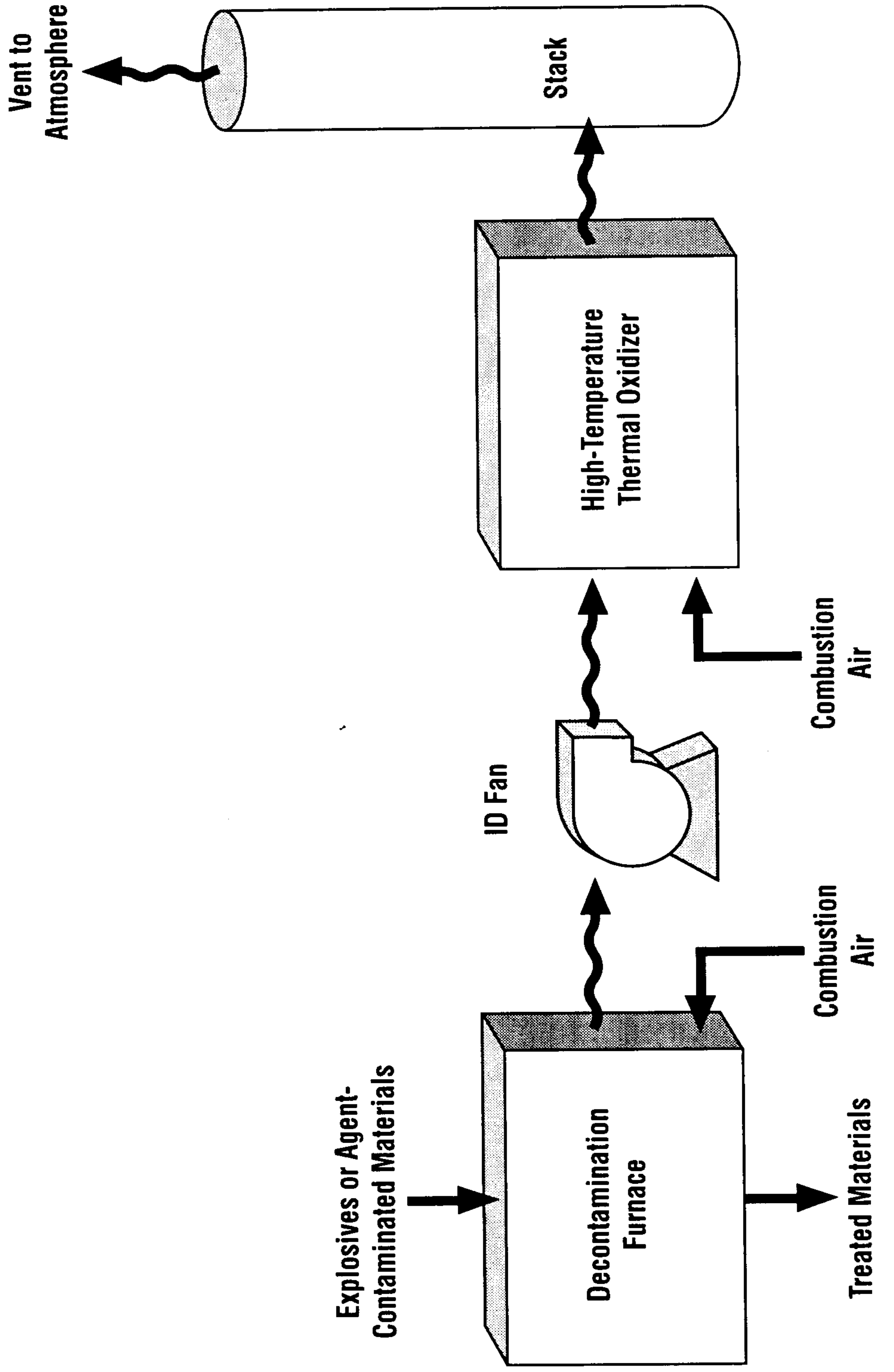


FIGURE 2-2 HGD SYSTEM PROCESS FLOW

96P-2957-1 9/18/96

fuel valves automatically open and the main flame is lit. The burner flame is acknowledged through the flame scanner. Failure to detect a flame signal once operations begin results in an automatic shutdown of gas flow to the furnace.

Gas flow to the furnace is controlled automatically based on the furnace chamber temperature. Combustion air to the burner is set at a fixed rate that maintains excess air capacity to promote lower furnace chamber temperatures between 300 and 700 °F.

A local control panel, located on the furnace skid, allows a few operating tasks to be performed locally. For example, an emergency stop pushbutton is located on this panel. However, despite the local panel, all furnace monitoring and control is accomplished through the remote control panel during decontamination operations.

The HGD process is a batch process. Each batch run involves:

- Loading the furnace.
- Starting the I.D. fan.
- Starting and heating the thermal oxidizer to 1,800 °F.
- Selecting and programming a furnace treatment temperature and soak time.
- Starting and heating the furnace to the selected treatment temperature.
- Treating contaminated materials at the selected treatment temperature.
- Decreasing the furnace temperature to shutoff.
- Cooldown of the furnace load.
- Shutting down the thermal oxidizer.
- Shutting down the I.D. fan.
- Unloading treated materials from the furnace.

All contaminated materials treated by the transportable HGD system must be manually loaded and unloaded. Loading materials into the furnace involves placing the contaminated materials onto racks and then loading the racks into the furnace using a forklift. A full furnace load consists of a total of **3,000 lb** of contaminated materials. This load limitation is based on the strength of the refractory floor and the required thermal input to heat the load. The 3,000 lb includes the weight of the materials plus the weight of the racks used to hold the contaminated materials in the furnace during treatment.

A total explosive limit of no more than 1 lb total explosives contamination per 3,000 lb of contaminated material (one furnace load) was imposed by permitting limitations established by the State of Alabama. The standard design and construction of the furnace exceeds this limitation; however, it is strongly suggested that proper explosion rating calculations be performed by qualified personnel before increasing the explosives load limitation of the furnace beyond 1 lb.

Because the furnace is manually loaded, the furnace has been equipped with a number of safety features:

- A protective cage mounted at the burner outlet.
- A kick-out door.
- Door switch (ZSO-208).

The protective cage is located inside the furnace, at the top of the furnace chamber. Its location prevents the placement or stacking of contaminated materials directly in front of the burner flame. The kick-out door, which is located within the main furnace door, is provided to allow a means of escape from the furnace chamber should personnel accidentally become locked inside the furnace. Door switch ZSO-208 is associated with the main furnace door and supports a control interlock condition that prevents system startup unless the main furnace door is closed.

Temperature of the furnace exit-gas is monitored by three separate temperature transmitters connected to a temperature controller. The controller maintains the desired furnace temperature by automatically adjusting fuel flow to the burner. An independent high-temperature switch provides over-temperature protection for the furnace. The furnace chamber temperature is documented on a real-time basis, by a circular chart recorder located on the furnace remote control panel.

The temperature of the treated material is measured by five thermocouples, which are connected to their respective temperature transmitters through a jack panel located on the furnace. The jack panel has room for up to 12 load thermocouples; however, only five transmitters were used to support treatment operations. Seven additional transmitters can be installed, if required. The five transmitters are connected to the data logging and monitoring system, where the transmitter signals are recorded for archiving and future use, and trended by a real-time graphics display, located in the control area.

2.2 I.D. FAN, THERMAL OXIDIZER, AND STACK

The thermal oxidizer system was furnished by Arrtech Environmental Systems, Inc., of Tulsa, Oklahoma. The thermal oxidizer system consists of the following elements:

- I.D. Fan.
- Thermal Oxidizer Combustion Chamber.
- Burner and Gas Train.
- Air Pre-Mix System.
- 24-Foot Exhaust Stack with an 8-Foot Extension.
- Local Control Panel.
- Remote Control Panel.

The thermal oxidizer has a horizontal combustion chamber equipped with a 2.75-million-Btu-per-hour burner. The system, with the exception of the remote control panel and stack, is skid-mounted for transportability. The equipment skid is approximately 29 feet long by 7.5 feet wide. The oxidizer is nominally designed to thermally treat approximately 3,400 lb/hr of contaminated off-gases from the furnace at a treatment temperature of 1,800 °F for a minimum residence time of 2 seconds. The maximum capacity of the thermal oxidizer is equivalent to the maximum capacity of the I.D. fan, which is rated for 4,758 lb/hr at 70 °F.

The thermal oxidizer combustion chamber is constructed of carbon steel and lined with a ceramic-fiber refractory. A turbulator, located halfway down the combustion chamber length, provides maximum combustion efficiency by creating turbulent flow conditions within the combustion chamber.

The burner assembly consists of a Maxon Air Flow Model LV5 gas manifold burner with an HG-4 mixer. The pilot and burner flames are monitored by a pilot and flame UV scanner system. Once all system interlocks are confirmed and a pilot flame is established, the main fuel valves automatically open and the main burner ignites. The burner flame is acknowledged through a flame scanner. Failure to detect a flame signal once the main flame has lit results in an automatic shutdown of fuel flow to the thermal oxidizer.

The Maxon burner is designed to use oxygen from the furnace exit-gas stream for combustion; however, a combustion air fan has been supplied with the burner system to provide pre-mix air to the burner in order to maintain excess oxygen levels in the combustion zone of the thermal oxidizer at all times. A temperature transmitter connected to a temperature controller monitors and controls the combustion chamber exit-gas temperature by modulating the fuel gas control valve.

Furnace exit-gases are directed into the thermal oxidizer combustion chamber through the I.D. fan. The I.D. fan is a centrifugal-type fan manufactured by Chicago Blower and is rated for 2,250 cubic feet per minute (cfm) at 650 °F. The I.D. fan has been sized to maintain a negative 0.5 inches water column (in. w.c.) of pressure in the furnace to prevent fugitive emissions and force the furnace exit-gas stream through the thermal oxidizer combustion chamber and out of the exhaust stack. The I.D. fan inlet is connected to the furnace chamber through an interconnection duct.

The stack, which is located at the discharge end of the thermal oxidizer system, is approximately 24 feet high with a 29-inch inside diameter (i.d.). The stack is shipped on its side, separate from the thermal oxidizer skid. The stack is outfitted with four test ports for periodic emissions sampling and one CEM port for continuous emissions monitoring of the system exit-gases. An 8-foot stack extension, containing four additional sampling ports, has been provided to support the ability to conduct a full suite of emissions tests during permit-related activities. The stack extension is not necessary for operations unless otherwise required by local permit.

2.3 CONTINUOUS EMISSIONS MONITORING (CEM) SYSTEM

The site-specific application of a CEM system will depend heavily on regulatory and facility operating requirements. The CEM system, which was used to support the transportable HGD system test programs at ALAAP, was a leased unit; therefore, the information provided below is for information only. This information can be used as a guide to procuring or leasing similar CEM system equipment to support future HGD projects.

The leased CEM unit was an extractive-type sampling system that had two fully operational sample systems with redundant analyzers and its own data acquisition and control system. The redundant analyzers were used as on-line backups to replace the primary analyzers in the event of calibration or analyzer failure. The CEM system was located in a self-contained, heated and air-conditioned trailer on the equipment pad near the HGD furnace. Refer to Figure 2-1.

The function of the CEM system is to sample, monitor, and log the gaseous emissions leaving the stack, and to sample, monitor, and log the exit-gases leaving the furnace during process operations. This sampling is accomplished by using one sample probe located at the stack and a second sample probe located at the interconnection duct. The combustion products that were continuously monitored at the stack by the CEM system during the test programs at ALAAP were CO, CO_2, O_2, NO_x, THC, and SO_2. The combustion products that were continuously monitored at the interconnection duct, between the furnace exit and thermal oxidizer inlet, were THC and NO_x.

A summary of the analyzers supplied with the leased CEM system and the manufacturer's performance specifications is presented in Table 2-1. A summary of the sample extraction and conditioning equipment that was provided with the leased CEM system is presented in Table 2-2.

2.4 REMOTE CONTROL AND SYSTEM INTERLOCKS

The HGD process is relatively simple to control. Furnace chamber temperature, thermal oxidizer temperature, and system draft are the process parameters that are critical to HGD system operations. To ensure operator safety while treating explosives-contaminated materials, all HGD system operations are controlled by the operator from the equipment-specific remote control panels located in the remote control area. No personnel are permitted on the equipment pad during system operations.

Each of the HGD system remote control panels were designed to be self-contained and able to operate independently of the other equipment panel. However, control interlock conditions have been installed to prevent system operations from starting or continuing when operating conditions pose an equipment-, treatment-, or safety-related problem. The interlocks create an interdependency between the furnace and thermal oxidizer systems that would not exist without the interlocks.

Critical operating parameters associated with the HGD process, including emissions data from the CEM, are monitored from the remote control area using the HGD data logging and monitoring system. Specifics regarding the data logging and monitoring system are provided in Subsection 2.5. Figure 2-3 illustrates the interconnection cabling, which allows both remote control operation and data logging and monitoring of the HGD system operating parameters.

Table 2-1
Summary of Continuous Emission Monitoring (CEM) Equipment

CEM Specifications	Parameter					
	O_2	CO_2	CO	NO_x	THC	SO_2
Number of CEMs	2	2	2	2	2	1[b]
Manufacturer Model Number	Servomex 1400	Infrared IR-730	Thermo Electron 48	Thermo Electron 10 AR	J.U.M. Engineers VE7	Bovar 721
Principle of operation	Paramagnetic	Nondispersive infrared absorption	Gas correlation filter infrared absorption	Chemiluminescence	Flame ionization detector	Nondispersive ultraviolet
Range **Accuracy**	0-25% ± 0.5%	0-20% ± 0.2%	0-500 ppm ± 2.5 ppm	0-250 ppm ± 2.5 ppm	0-100 ppm ± 1.0 ppm	
Analyzer stability over 24 hours (percent span)[a]	2.0%	1.0%	1.0%	1.0%	1.0%	

[a]Since the system is calibrated daily and the ambient temperature is maintained on-line at all times, this drift will be negligible.

[b]Each analyzer is dedicated to a sample point, no spare analyzer is provided.

Table 2-2

Sample Extraction and Conditioning Equipment

Item	Description	Performance Parameters	Locations
Sample probe and cooling section	Inconel tubing with 316 stainless-steel fittings.	Reduce gas temperature < 400 °F.	Sample port in thermal oxidizer exhaust stack (CO, CO_2, O_2, and NO_x, SO_2, THC). Sample port in furnace exhaust to duct (NO_x only).
Sample box	Carbon steel box with ceramic insulation and fitting connections for calibration gas introduction.	Maintains sample temperature at $\geq$ 300 °F.	Insulated closure adjacent to the sample port at the thermal oxidizer exhaust stack.
Sample line	Heated Teflon TFA tubing.	Maintain sample temperature at $\geq$ 300 °F.	Between sample location and CEM trailer, as required.
Main thermal oxidizer exhaust sample (for CO, CO_2, NO_x, SO_2, and O_2) conditioning system and auxiliary furnace exhaust sample (NO_x only)	Heated filter, pump, mechanical refrigeration chiller, condensate trap, coalescing filter, pressure regulator, and flow meters. Teflon and stainless-steel construction.	Exit dew point at $\geq$ 38 °F; removal of particulate > 0.3 micron.	In CEM trailer; draws wet sample directly from heated sample line; delivers cool, dry conditioned sample directly to CO, CO_2, NO_x, SO_2, and O_2 analyzers.
THC sample conditioning system, thermal oxidizer exhaust	Heated fine filter.	Removal of particulate > 0.3 micron.	Internal to THC analyzer; draws sample directly from heated sample line.

2.5 DATA LOGGING AND MONITORING SYSTEM

To allow for data acquisition and monitoring capabilities during process operations, data highway cabling must be installed, which interconnects the local furnace and thermal oxidizer system control panels, the remote furnace and thermal oxidizer control panels, the CEM monitoring system, and the remote control area-based personal computer (PC). The data highway cable daisy-chains between communication interface cards in the remote control area PC, and modules located at the CEM and at each of the local and remote control panels. The RS-485 I/O cards provide the interface necessary to transfer process instrument data (4-20 mA signals) from the field instrument to the remote control area PC. Data received at the remote control area PC are then used by the data logging and monitoring program to provide system archiving, real-time trending, and up-to-the minute process operating values. This scheme is illustrated by the Data Logging and Monitoring System illustration in Figure 2-4.

The data acquisition and monitoring system (data logger) used to support data logging and monitoring is a Windows-based program operated from a Pentium platform. The program allows the operator to:

- View and monitor real-time operational data on a graphical display illustrating the system equipment.
- Track historical operating data (trends) for selected process parameters.
- Archive operational data from each test run for later reduction and analysis.

The data logging and monitoring system uses the GENIE software package, which was written and supplied by American Advantech Corp. of Sunnyvale, California. GENIE software must be programmed by the user, and was programmed by WESTON to support the data acquisition needs of the HGD system equipment. Although the software capability exists, GENIE was not programmed for interactive control of the HGD equipment because interactive, remote system control is accomplished through the use of the equipment-specific remote control panels located in the remote control area.

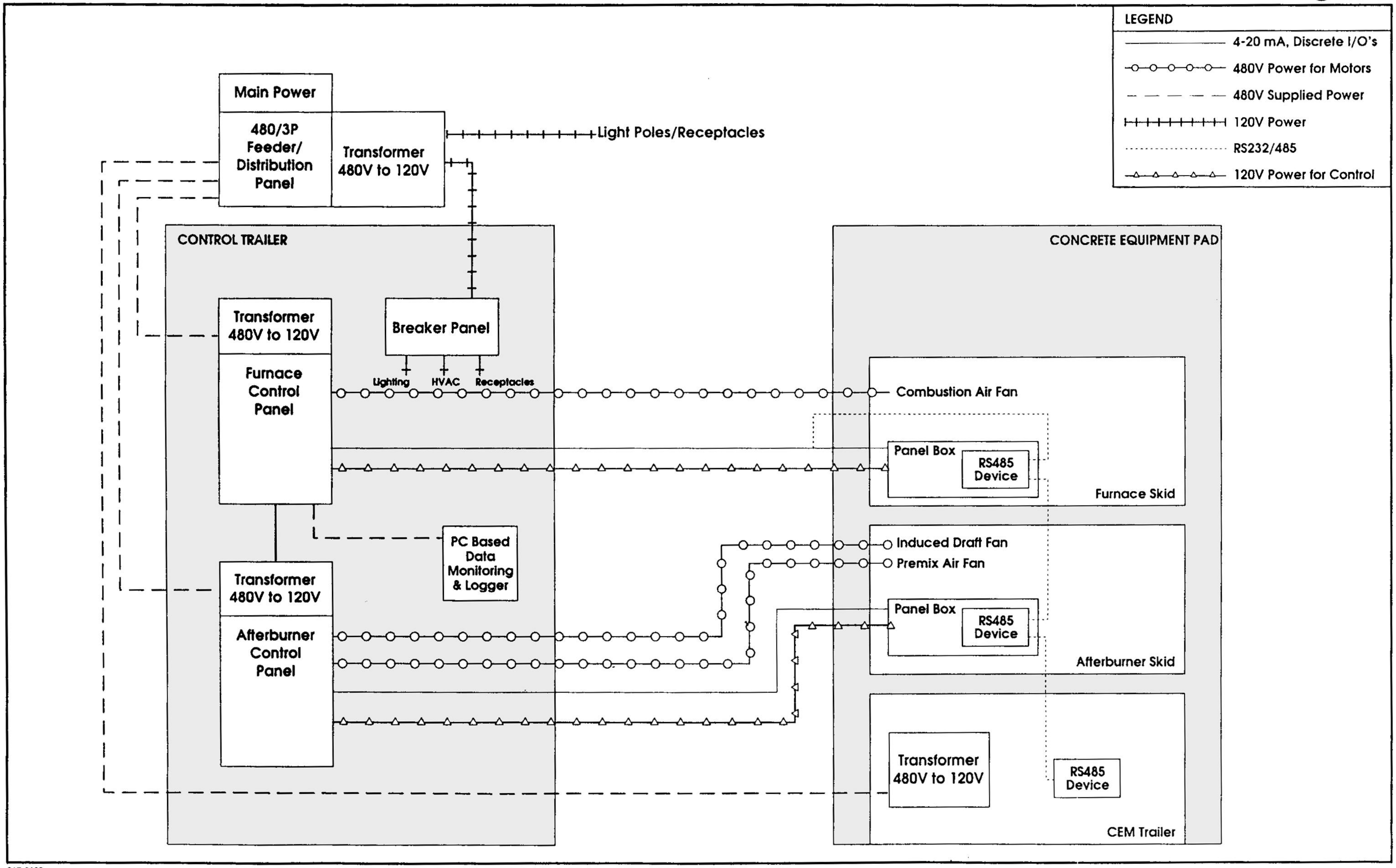


FIGURE 2-3 INTERCONNECTION WIRING DIAGRAM

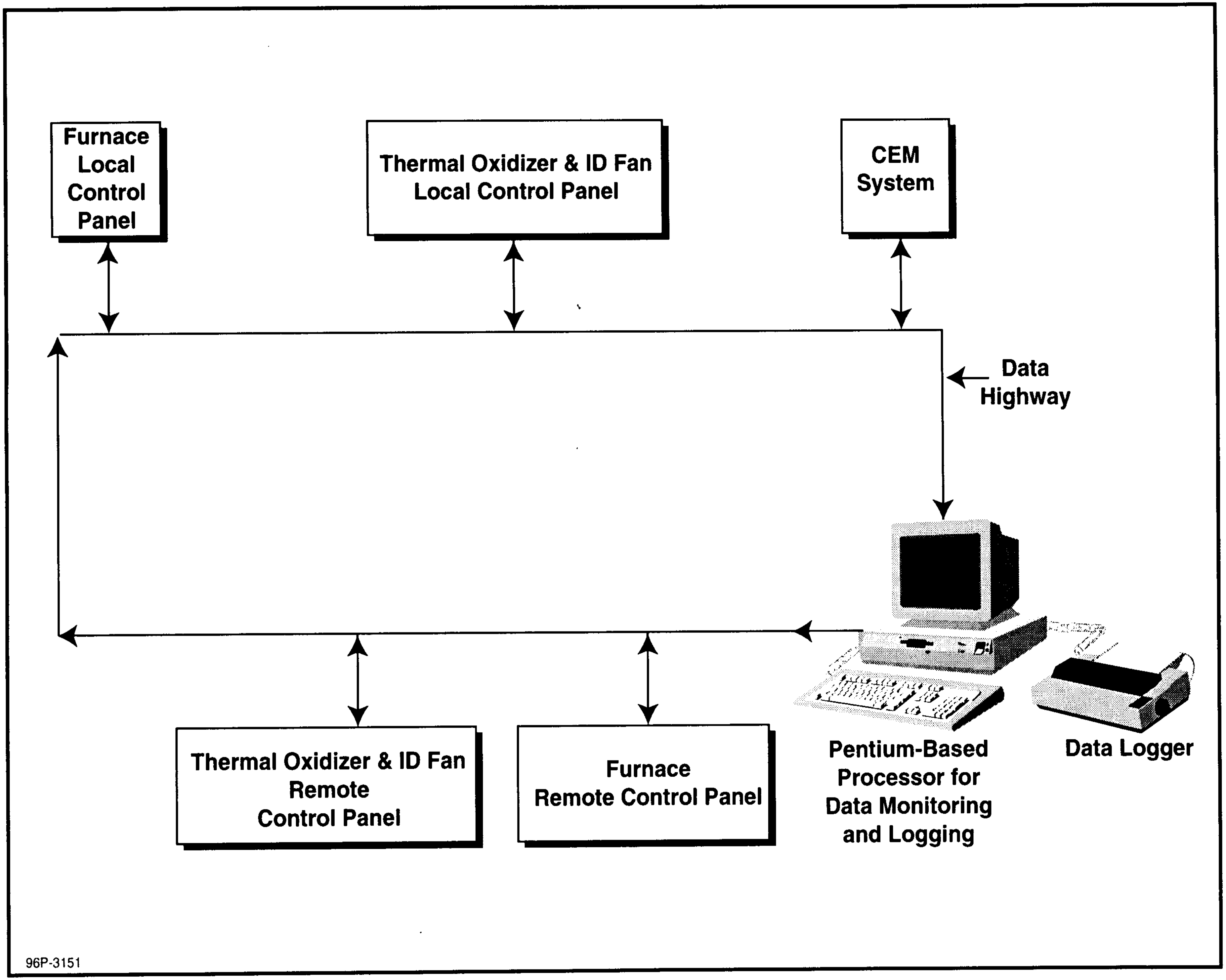


FIGURE 2-4 HGD SYSTEM DATA LOGGING AND MONITORING SYSTEM

3. INSTALLATION REQUIREMENTS

3.1 INSTALLATION REQUIREMENTS

As illustrated in Figure 2-1, the overall physical dimensions of the HGD system are relatively small and require minimal real estate (60 feet by 75 feet). However, in selecting the proper installation, environmental and safety requirements directly associated with the contaminant to be treated must be considered. For example, the installation must meet quantity-distance requirements associated with storage and use of explosives, as well as static electricity control and grounding requirements as defined by AMC-R-385-100 and AR 385-64. In the case of chemical contamination, quantity-distance requirements are not an issue; however, the installation must address applicable chemical hazards standards and recommendations. In all cases, National Fire Protection Association (NFPA) requirements must be met. Stormwater runoff and management must be addressed, as required by local regulation.

Figure 3-1 illustrates the site layout used for the demonstration and validation testing of the HGD system equipment installed at ALAAP. In accordance with AMC-R-385-100 and AR 385-64, the HGD equipment was located a minimum of 670 feet away from any manned location (i.e., remote control area buildings, etc.) and a minimum of 350 feet from a railroad or active roadway. The propane fuel storage tank was located 100 feet from the HGD equipment in accordance with NFPA requirements. All stormwater runoff from the equipment pad was collected and directed to an existing water treatment plant associated with an unrelated ongoing remediation effort at ALAAP.

3.2 REGULATORY PERFORMANCE STANDARDS

The HGD process is classified as a thermal treatment system. Regulatory performance standards for processing hazardous and toxic wastes using a thermal treatment system are outlined in Chapter 40 of the Code of Federal Regulations (40 CFR).

The transportable HGD system is designed to meet all applicable regulatory performance standards contained in the following sections of 40 CFR:

- Resource Conservation and Recovery Act (RCRA) incinerator standards specified in 40 CFR, Part 264, Subpart O.
- Miscellaneous Unit standards specified in 40 CFR, Part 264, Subpart X.
- Boiler and Industrial Furnace standards specified in 40 CFR, Part 266, Subpart H.

- Toxic Substances Control Act (TSCA) incinerator standards specified in 40 CFR, Part 761.70(b).

3.3 REGULATORY APPROVAL REQUIREMENTS

Federal and state regulatory agency approval must be obtained prior to the start of any operations using the transportable HGD system equipment. Requirements for approval will primarily depend on:

- Classification of the site with regard to the Comprehensive Environmental Response and Liability Act (CERCLA).

- The type of contaminants to be treated (RCRA, TSCA, or nonhazardous).

- The levels of contaminants (higher concentrations of contaminants may trigger air emissions limitations, which vary throughout the country).

Permit/approval requirements* for an HGD treatment system are expected to be as follows:

Type of Waste	CERCLA Site	Non-CERCLA Site
RCRA	Part B Permit State Air Permit	Part B Substantive Technical Information Requirements State Air Permit Substantive Technical Information Requirements
TSCA	TSCA Permit State Air Permit	TSCA Permit Substantive Technical Information Requirements State Air Permit Substantive Technical Information Requirements
Nonhazardous	State Air Permit	State Air Permit Substantive Technical Information Requirements

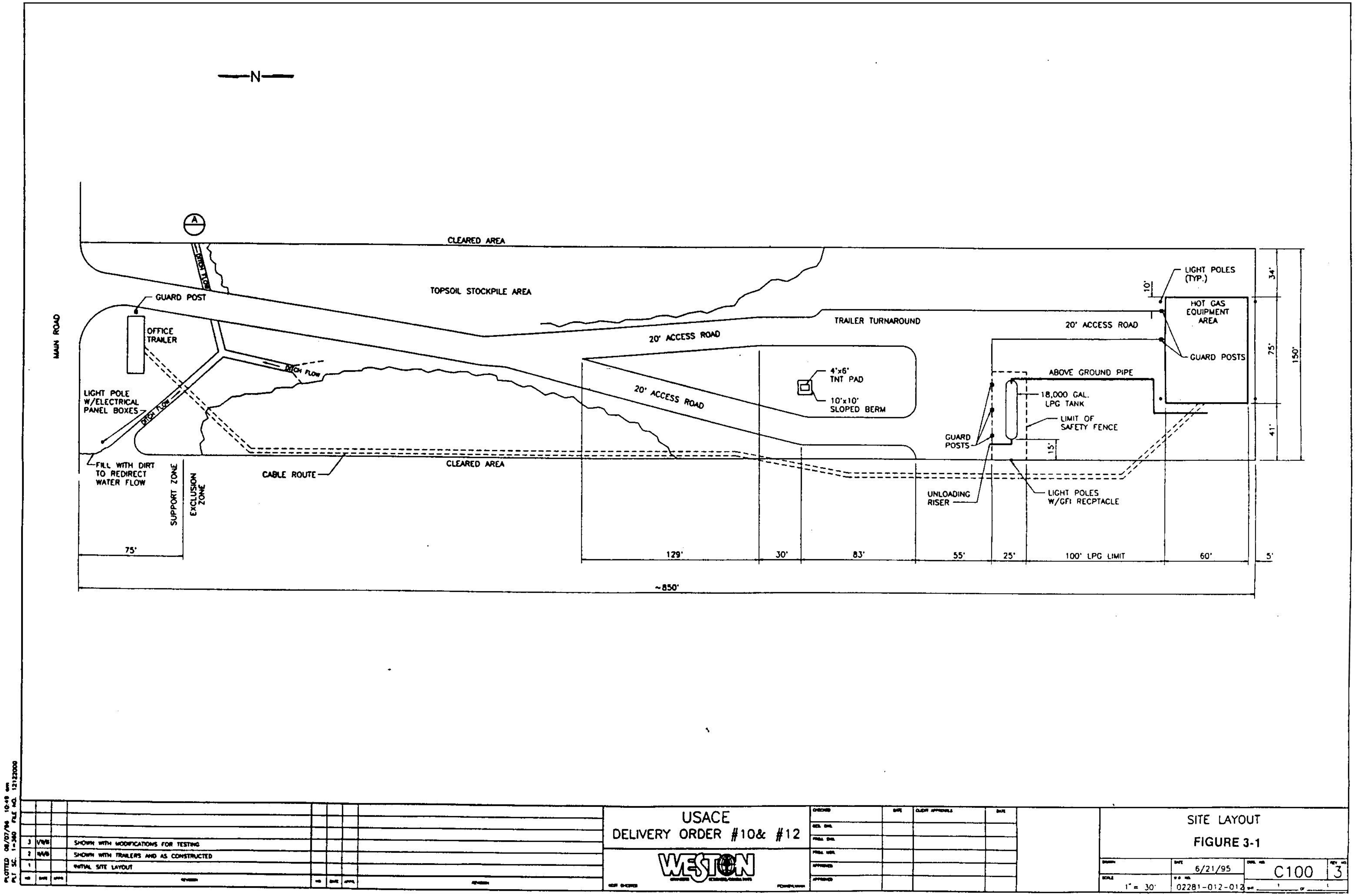
3.4 UTILITY REQUIREMENTS

At a minimum, the HGD system equipment requires both electricity and fuel in accordance with the requirements noted below:

Electrical: 90-amp service, at 480 VAC, 3 phase, 60 hertz

Fuel: Natural gas or propane, 3.75 million Btu/hour (37.5 therms/hour) at 20 psig

* Federal and state regulatory agencies must be contacted to verify permit/approval requirements.


N
A
CLEARED AREA
TOPSOIL STOCKPILE AREA
MAIN ROAD
GUARD POST
OFFICE TRAILER
DITCH FLOW
LIGHT POLE W/ELECTRICAL PANEL BOXES
FILL WITH DIRT TO REDIRECT WATER FLOW
SUPPORT ZONE
EXCLUSION ZONE
CABLE ROUTE
CLEARED AREA
20' ACCESS ROAD
20' ACCESS ROAD
TRAILER TURNAROUND
20' ACCESS ROAD
4'x6' TNT PAD
10'x10' SLOPED BERM
LIGHT POLES (TYP.)
HOT GAS EQUIPMENT AREA
GUARD POSTS
ABOVE GROUND PIPE
18,000 GAL. LPG TANK
LIMIT OF SAFETY FENCE
GUARD POSTS
UNLOADING RISER
LIGHT POLES W/GFI RECPTACLE
10'
34'
75'
150'
41'
15'
75'
129'
30'
83'
55'
25'
100' LPG LIMIT
60'
5'
~850'
3 SHOWN WITH MODIFICATIONS FOR TESTING
2 SHOWN WITH TRAILERS AND AS CONSTRUCTED
1 INITIAL SITE LAYOUT
USACE
DELIVERY ORDER #10& #12
WESTON
SITE LAYOUT
FIGURE 3-1
6/21/95
C100
3
1" = 30'
02281-012-012

Other utilities, such as telephone service or water, are not necessary for the operation of the HGD system, but may be required to meet site-specific health and safety requirements. The daily operating schedule may require site lighting for night-time operations. Water should be considered for periodic equipment washdowns and cleanup.

3.5 PROCUREMENT AND INSTALLATION SCHEDULE

A generic project schedule to procure and install a transportable HGD system is illustrated in Figure 3-2. This schedule is based on the actual project schedule to procure and install the transportable HGD system at ALAAP. Please note schedule task durations may vary depending on project or site-specific requirements.

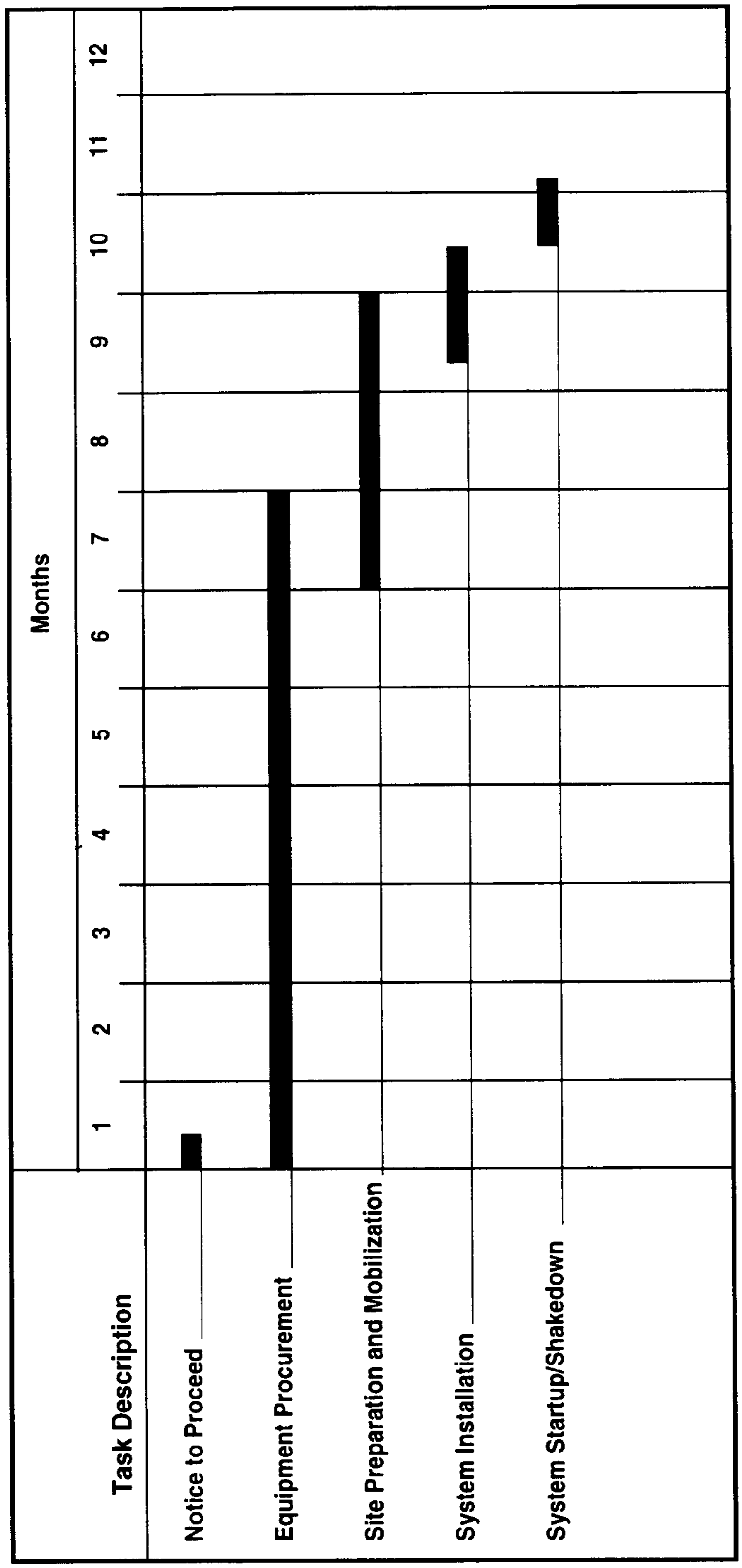


FIGURE 3-2 HGD SYSTEM PROJECT SCHEDULE

96P-3208 9/20/96

4.
HGD SYSTEM COST

The total costs associated with the transportable HGD system can be broken down into the following cost items, and are further detailed in Subsections 4.1 through 4.4.

- Capital equipment costs.
- Installation and startup costs.
- Operating costs.
- Validation testing costs.

4.1 CAPITAL EQUIPMENT COSTS

All capital equipment costs provided in this subsection are based on the skid-mounted, transportable HGD system that was procured for USAEC in fiscal 1995. All instrumentation and electrical systems supplied with the transportable HGD equipment were capable of remote and local operations, and qualified to operate in National Electrical Code (NEC) and NFPA Class 1, Division 2, Group D environments.

<u>Furnace</u>	$156,000

Includes furnace, 1 million Btu/hr gas-fired burner, burner controls, combustion air blower, and local and remote control panels.

<u>Thermal Oxidizer</u>	$180,000

Includes 2.75 million Btu/hr gas-fired thermal oxidizer, stack, air pre-mix system, and local and remote control panels.

<u>Interconnection Duct</u>	$5,500

Includes materials and fabrication costs.

<u>I.D. Fan</u>	$9,000

Centrifugal-type rated for 2,250 cfm at 650 °F (700 °F maximum operating temperature) remote controlled variable frequency drive.

<u>Miscellaneous Equipment</u>	$35,000

Power and instrument cables, computers, software, treatment racks, uninterruptable power supply.

<u>Continuous Emission Monitoring System (Optional)</u> $286,000

Extractive-type, redundant system for monitoring O_2, CO, CO_2, THC, SO_2, and NO_x. System meets 40 CFR 60, Appendix A and B requirements.

<u>Control Trailer (Optional)</u>

8 feet by 40 feet with office space and restroom. $18,000

4.2 INSTALLATION AND STARTUP COSTS

Installation costs will vary from site to site and from job to job because of local conditions, labor costs, and equipment transportation costs. Items that should be considered in estimating installation costs are identified in Subsections 4.2.1 through 4.2.3.

4.2.1 Site Preparation

Site preparation costs can be expected to vary, depending on the location and condition of the site to be used. Site preparation items can also have a significant impact on installation costs, especially if a selected site is undeveloped. Site preparation items that may be required prior to mobilization of the HGD equipment to the selected site include the following:

- Site clearing and grubbing.
- Site grading.
- Installation, static control, lightning protection grid, and grounding grid.
- Equipment pad installation.
- Installation of site lighting.
- Installation of an electrical service.
- Installation of telephone service.
- Installation of a fuel source.
- Installation of water service.
- Installation of sanitary sewer system.
- Installation of fire protection.

4.2.2 Transportation and Mobilization to Site

The transportable HGD system is mobilized using three low-boy-style trailers (one each for the furnace, the thermal oxidizer, and the stack and miscellaneous equipment). A low-boy style trailer would be required for either the CEM or the control trailer should either item be required to support operations. The skid-mounted equipment can be removed from the trailers, by a crane or heavy forklift, and placed on an equipment pad, as required for operations. A 1-day crane or heavy forklift rental is adequate to support this operation.

4.2.3 System Shakedown and Startup

System shakedown to verify electrical connections, instrument calibrations, and general system operating integrity should be performed prior to actual treatment of contaminated materials by the HGD system equipment. Approximately four persons, for 3 weeks, are required to perform shakedown. Shakedown operations include:

- Installation of interconnecting instrument and control cabling.
- Instrument calibration and checkouts.
- System functionality testing.

4.3 OPERATING COSTS

The pricing listed below is based on one transportable HGD system operated at ALAAP between December 1995 and March 1996. Costs are expected to vary from site to site depending on the costs of labor and utilities and selected operating conditions.

Electricity:	$100/day per unit
Propane:	$725/day per unit
Propane delivery system equipment (15,000 GWC storage tank):	$40/day per unit
CEM calibration gases:	$60/day per system
Incidentals and miscellaneous parts:	$60/day per unit
Labor (assume 3 workers: 1 control area operator and 2 laborers/mechanics):	$2,352[1]/day

All costs per day noted above assume a 24-hour day and a minimum processing rate of 4 batch runs per 24-hour day.

4.4 VALIDATION TESTING COSTS

Depending upon site-specific regulatory and facility requirements, validation testing including stack emissions testing may be required. Based upon stack emissions testing conducted at ALAAP, the estimated cost for validation testing is approximately $90,000 and can be expected to last approximately 7 days. This cost assumes standard laboratory turnaround times.

[1] Labor costs per 24-hour day assumes all labor is employed directly by the user at the following rates: $26.00/hr for control area operators; $15.00/hr for laborers; and a 1.75 multiplier for taxes and fringes.

5. SYSTEM PERFORMANCE

5.1 DEMONSTRATION AND VALIDATION TEST PROGRAMS

A successful demonstration test program, using the transportable HGD system equipment and clean, noncontaminated materials, was conducted between 4 and 8 December 1995 at ALAAP. The demonstration test was conducted to verify:

- General system performance.
- Ease of operation.
- System repeatability.

As a result of demonstration test operations, system modifications were made with the following results:

- Minimization of furnace cold spots.
- Improvement of the overall heat distribution profile within the furnace.
- Reduction of furnace heat-up times to < 2.5 hours.
- Maximization of system operating efficiencies.

After completing the demonstration tests and modifications, a validation test program was conducted from 4 January to 15 March 1996 at ALAAP. The validation test program was conducted under the federal guidelines regulating a treatability study; therefore, no permitted limits for system emissions or operating conditions were specified. The objectives of the validation test program were as follows:

- To verify the effectiveness of the HGD system equipment in decontaminating explosives (TNT, RDX, and Tetryl).

- To define optimum processing times and temperatures for TNT-, RDX-, and Tetryl-contaminated materials.

- To collect air emissions data to support future system permitting efforts.

Eighteen test runs were conducted at treatment temperatures ranging from 300 °F to 600 °F. A full furnace load was composed of 3,000 lb of TNT-, RDX-, and Tetryl-contaminated metal piping, clay piping, and concrete block, as well as explosives-contaminated debris from another remediation project at ALAAP. No more than 1 lb total explosives was processed in any test run.

5.2 RESULTS OF THE VALIDATION TEST PROGRAM

The validation test of the transportable HGD system equipment was a success. Results of the tests are highlighted below.

- The optimum operating conditions for achieving complete removal of TNT, RDX, Tetryl, and their breakdown constituents to levels below method detection levels is:

  - 250 °F/hour ramp to 600 °F treatment temperature with a 1-hour soak.

- NO_x monitoring at the furnace exit indicates that the bulk of explosives decontamination occurs during the furnace ramp (250 °F to 600 °F) period.

- Post-treatment analytical testing consistently indicated removal efficiencies for TNT, RDX, and Tetryl of 99.9999%, based on an initial quantity of 1 lb total explosives.

- The HGD process effectively processed explosives-contaminated debris to microgram quantities while achieving at least 99.99% destruction and removal efficiency.

- The transportable HGD system is a fully instrumented and monitored process which together with the control system ensures repeatability test after test.

5.3 EMISSIONS RESULTS

Stack emissions data were collected during the first three validation test runs and CEM data were collected during all test runs. Results indicate the following:

- No detectable explosives contamination was observed in the stack emissions from the HGD system equipment.

- Volatile and semivolatile sampling was conducted to evaluate for products of incomplete combustion and breakdown compounds. Results indicated:

  - Only acetone, which was used to make the spike mixtures, was found in any significant quantities.

  - Only nontarget semivolatile compounds were identified. Semivolatile samples were analyzed for target compound list compounds.

A summary of the HGD system emissions results is located in Table 5-1.

Table 5-1

Transportable HGD System Equipment Emissions Results

Hazardous Air Pollutant	Existing Standard (as of June 1996)	Test Run Average
Total hydrocarbons (ppmv)	12	**<1.0**
Carbon monoxide (ppmv)	100	**<1.0**
Particulate (gr/dscf at 7% O_2)	<0.08	**0.0004**
Hexavalent chromium (µg/dscm)	NA	**12.18**
Low-volatility metals (µg/dscm) (antimony, arsenic, beryllium, chromium)	210 (currently) 60 (proposed)	**15.03**
Semivolatile metals (µg/dscm) (lead and cadmium)	270 (currently) 62 (proposed)	**2.33**
Total chlorine (ppmv) (HCl and Cl_2)	280	**0.36**
Mercury (µg/dscm)	50	**0.04**
Dioxins/furans (ng TEQ/dscm)	0.2	**0.03**

5.4 CONTINUOUS EMISSIONS MONITORING RESULTS

Total hydrocarbons (THC), sulfur dioxide (SO_2), nitrous oxides (NO_x), carbon monoxide (CO), and carbon dioxide (CO_2) emissions measured by the CEM system were significantly below the limits usually associated with permitting.

NO_x levels monitored in the furnace exit-gas duct indicated increased NO_x activity during ramp-up periods and a return to baseline NO_x levels after the furnace chamber temperature reached approximately 400 °F. Future studies with HGD hope to use NO_x levels in the furnace exit-gas as an indicator of a completed decontamination batch run.

This Page Intentionally Left Blank

MATERIAL INSPECTION AND RECEIVING REPORT

1. PROC. INSTRUMENT IDEN. (CONTRACT)	DACA 31-91-D-0079
(ORDER) NO.	0012
6. INVOICE	
7. PAGE 1 OF 1	
8. ACCEPTANCE POINT	
2. SHIPMENT NO.	RFW# A016
3. DATE SHIPPED	23 September 1996
4. B/L	TCN
5. DISCOUNT TERMS	

9. PRIME CONTRACTOR	CODE	10. ADMINISTERED BY	CODE
Roy F. Weston, Inc. 1 Weston Way West Chester, PA 19380-1499	2M 222	DCMAO Philadelphia Attn: DFAS - c/o Cont. Mgmt Liaison P.O. Box 7699 Philadelphia, PA 19101-7699	539 15A

11. SHIPPED FROM *(if other than 9)*	CODE	FOB:	12. PAYMENT WILL BE MADE BY	CODE
See block 9			DFAS Columbus Center Attn: DFAS All American Division P.O. Box 182137 Columbus, OH 43218-2137	SC 1014

13. SHIPPED TO	CODE	14. MARKED FOR	CODE
Commander SFIM - AEC - ETD (Kanaras) Bldg E4430; Edgewood Area Aberdeen Proving Ground, MD 21010-5401	CETHAM		

15. ITEM NO.	16. STOCK/PART NO. DESCRIPTION *(Indicate number of shipping containers - type of container - container number.)*	17. QUANTITY SHIP/REC'D*	18. UNIT	19. UNIT PRICE	20. AMOUNT
A016	Cost and Performance Report for the Evaluation of Transportable Hot-Gas Decontamination System Equipment for the Decontamination of Explosives-Contaminated Piping and Debris	5			

21. PROCUREMENT QUALITY ASSURANCE

A. ORIGIN

☐ PQA ☐ ACCEPTANCE of listed items has been made by me or under my supervision and they conform to contract, except as noted herein or on supporting documents.

DATE SIGNATURE OF AUTH GOVT REP

TYPED NAME AND OFFICE

B. DESTINATION

☐ PQA ☐ ACCEPTANCE of listed items has been made by me or under my supervision and they conform to contract, except as noted herein or on supporting documents.

DATE SIGNATURE OF AUTH GOVT REP

TYPED NAME AND OFFICE

22. RECEIVER'S USE

Quantities shown in column 17 were received in apparent good condition except as noted.

DATE RECEIVED SIGNATURE OF AUTH GOVT REP

TYPED NAME AND OFFICE

* *If quantity received by the Government is the same as quantity shipped, indicated by (✓) mark, if different, enter actual quantity received below quantity shipped and encircle.*

23. CONTRACTOR USE ONLY

WESTON has submitted the Contract Data Requirements listed as sequence number A016 on form DD1423, as set forth in the basic contract for Delivery Order #12.

Michael G. Cosmos, Program Manager/Project Director

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY (Leave blank)

2. REPORT DATE
September 1996

3. REPORT TYPE AND DATES COVERED
Cost and Performance Report

4. TITLE AND SUBTITLE

Cost and Performance Report for the Evaluation of a Transportable Hot-Gas Decontamination System Used to Support the Decontamination of Explosives-Contaminated Piping & Debris.

5. FUNDING NUMBERS

DACA31-91-D-0079
Delivery Order 12

6. AUTHOR(S)

Roy F. Weston, Inc.

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

Roy F. Weston, Inc.
1 Weston Way
West Chester, PA 19038-1499

8. PERFORMING ORGANIZATION REPORT NUMBER

N/A

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

U.S. Army Environmental Center
Environmental Technology Division
Edgewood Area
Aberdeen Proving Ground, MD 21010-5401

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT

Unlimited Distribution/Availability

12b. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)

The United States Army Environmental Center (USAEC) has been conducting laboratory investigations and pilot-scale studies of the hot-gas decontamination (HGD) process since 1978. The results from these investigations and studies verified the effectiveness of the HGD technology for treating chemical agent and explosives, however, post-test recommendations indicated that equipment designed specifically for the HGD concept would improve system efficiencies and process optimization goals. As a result, USAEC contracted Roy F. Weston, Inc. to design and procure system equipment specifically for the treatment of explosives-contaminated materials by the HGD process. The resultant equipment design was delivered to USAEC's test site at the Alabama Army Ammunition Plant (ALAAP) located in Alpine, Alabama for demonstration and validation testing.

The demonstration and validation testing was conducted between 4 December 1995 and 15 March 1996. The test program was a success. System trials proved the HGD Equipment to be fully functional and capable of maintaining anticipated treatment temperatures. The HGD Equipment system was optimized to enable the complete destruction of explosives contamination at a furnace ramp rate of 250 °F/hr treatment temperature of 600 °F, and a treatment time of 1 hour. This report details the cost associated with the installation, operation, and performance of the optimized HGD System.

14. SUBJECT TERMS
Hot-Gas Decontamination Equipment
Cost and Performance
Explosives
Hot-Gas Decontamination Furnace
Thermal Oxidizer

15. NUMBER OF PAGES
30 Text
0 Appendices

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	**18. SECURITY CLASSIFICATION OF THIS PAGE**	**19. SECURITY CLASSIFICATION OF ABSTRACT**	**20. LIMITATION OF ABSTRACT**
Unclassified	Unclassified	Unclassified	None

NSN 7540-01-280-5500

Standard Form 298 (Rev 2-89)
Prescribed by ANSI Sta Z39-18
Z98-102